EFFECT OF THREE WASHING STEPS ON THE BIOCHEMICAL PROPERTIES AND QUALITY OF SURIMI PREPARED FROM MINCED CATFISH *(CLARIAS GARIEPINUS)* "KARMOUT"

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ABSTRACT

Surimi is the fish protein prepared by washing minced fish flesh after removing thorn. Catfish (Karmout) has many of undesirable characteristics including the short storage life. Production of surimi from Karmout consumes large amounts of washing water. In general, changes due washing should be studied first before trials to decrease the water consumption during processing, which was the aim of this investigation.

In the present work, the effect of washing on the quality of minced catfish using three washing steps to obtain Karmout surimi was investigated. By this method the minced flesh washed using $NaHCO_3$ (0.2%), followed by distilled water and lastly with NaCl (0.15%). Our results revealed that most loss in yield occurred through the 2nd step (distilled water) and the 3rd step (NaCl) of washing. As a result of washing the per cent of moisture, total protein and salt extractable protein increased, while fat and ash levels decreased. Furthermore, it was found that the pH value showed a slight increase due to washing. The three washing steps improved the water holding capacity of minced fish especially at the 1st step of washing. Values of total volatile bases nitrogen and trimethylamine as well as the thiobarbituric acid value decreased gradually due to washing.

Keywords: Minced catfish, surimi, seafoods, yield, washing steps, *Clarias gariepinus.*

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INTRODUCTION

Seafoods and their products are recognized as an important source of nutrients; this led to increasing consumption. Protein, lipids and bioactive components from seafoods have unique characteristics that differ from those of land animals (Shahidi, 1997). Surimi is the stabilized myofibrillas protein obtained from mechanically deboned fish flesh that is washed with water, mixed with cryoprotectants, and then frozen (Park and Morrissey, 2000).

The majority of channel catfish (locally called Karmout) is distributed in ice and mainly sold as fresh whole. Karmout has low market values as compared to other species of fresh water fish, It has many undesirable characteristics such as rapid development of rancid off-flavor, changes in color, water holding capacity, texture and low nutritive value (Thed *et al.*, 1993).The short shelf life of frozen catfish tissue is attributed to the formation of rancid odors and flavors, which arise from the oxidation of unsaturated fatty acids (Erickson, 1993). The process to produce catfish surimi requires large volume of water to remove blood, pigments, lipids and water-soluble proteins from minced meat. Reduction of the water volume required during washing steps would lower the production cost and reduce space required for waste water treatment as well as is ecologically important environmental to reduce the problems of pollution.

El-Sharnouby and Moharram (1994) used stepwise washing system to wash bolti mince using 0.2% $NaHCO_3$; distilled water and 0.15% NaCl, respectively. Changes due to the three washing steps should be studied first before trials to decrease the water consumed during processing. Therefore, El-Shourbagy *et al.* (2003) found that the yield, pH, total volatile nitrogen (TVB-N), thiobarbituric asid (TBA) and microbiological count for the washing minced catfish were lower than the unwashed mince. Also, minced meat recovered from filleted catfish frames yields 50% to 75% of the frames total weight (Hoke 1993). The present research was conducted to examine the effect of washing on the biochemical and quality characteristics of washed catfish mince prepared using the traditional method (three washing steps).

MATERIALS AND METHODS

Fresh catfish (*Clarias gariepinus*) Karmout were purchased from a local market in Zagazig city at Sharkia governorate, Egypt, in spring season of 2005. The total fish weight was two hundred and thirty kilograms of live catfish. Fish were washed thoroughly, head and gut removed, filleted and skinned. Mince was prepared from skinless fillets using a Moulinex meat minced. The obtained mince was subjected to stepwise washing using first 0.2% $NaHCO_3$, then distilled water and lastly 0.15%NaCl, using 3:1 (V:W) solution to mince ratio. The mince was stirred into the liquid and allowed to settle after which the solution was drained from the mince.

Analytical Methods

Moisture, protein, fat and ash contents were determined according to the methods described by (AOAC, 2005). The pH value was assessed as described by Carball *et al.* (1995). Water holding capacity (WHC) was determined according to the method mentioned by Jin *et al.* (2007). Salt extractable protein was measured according to the method recommended by Webb *et al.* (1976). Determination of total volatile bases nitrogen (TVB-N) and trimethylamine (TMA) carried out as recommended by the A.M.C. (1991). thiobarbituric acid (TBA) was determined according to the method mentioned by Tarladgis *et al.* (1960).The concentration of heavy metals mercury (Hg), lead (Pb) and cadmium (Cd) were determined using Atomic Absorption Spectrophotometar according to Diaz *et al.* (1994).

Microbiological Determinations

Total bacterial count were determined as recommended by Ravendra and Amjad (2005). Psychrophilic plate count were counted according to the method mentioned by Difico (1977). After counting the growth colonies, the CFU/g was calculated as follows:

CFU/g = (DF) x (Colonies count).

Whereas: DF= Dilution factor.
CFU= Colony forming units.

Coliform group was counted in pouring plates of MacConkey agar medium (Oxid Unipath LTD., Basingstoke, Hampshire, England). The plates were incubated at 37˚C for 24-28 hrs as described by Mossel (1975).

RESULTS AND DISCUSSION

Effect of Mincing and Washing Method on the Yield Percentage of Minced Catfish (Karmout)

Togoda *et al.* (1992) reported that the yield varies according to the original size of the fish, the presence or absence of roe and the season. However, the yield should be determined empirically for each processing plant and the process should be adjusted in such a manner that the yield falls within the specified limits. Table 1 showed that the yield of minced fish was 45.61% of whole fish weight. In this concern Suvanich *et al.*, (2000) reported that the total yield of minced fish flesh from various fish species ranges from 37 to 60% based upon round weigh. Thus, Awad and Abdel-Aal, (1994) found that the yield of Nile Karmout fish (*Claries lazera*) fillet was from 49.06 to 47.0%.

Data in the same Table also reveals that the yield after the first washing step by $NaHCO_3$ was 32.38% while the second washing step with distilled water gave the highest mince yield (33.25%), may be due to water absorbed by mince protein. After third washing step the mince yield again decreased to 27.96%. The observed losses in mince during the stepwise washing process induced by removal of the water soluble substances, fat and small mince meat particles during washing and dewatering processes.

These results are in agreement with that reported by Lee, (1986) who mentioned that a considerable quantity of soluble materials were lost during washing and most of the mince washing losses (30% on a mince meat basis) occurred during dewatering as a result of passing the filter. Additionally, substances removed within the second and third washing were markedly less significance comparing with those between first and second washing. Abdel-Aal and Ibrahim (2000) found that the yield after washing and dewatering ranged between 18-33% (as whole fish weight).

Effect of Washing Method on Chemical Composition of Minced Catfish (Karmout)

The data presented in Table 2 show that moisture content of unwashed fish flesh was 76.05% increased to 79.53% after the first washing step with $NaHCO_3$. This increment was more pronounced after the second washing step with

Table 1. Effect of the three washing steps on yield percentage of minced catfish (Karmout)

Treatments	Yield from whole fish (%)
Whole fish	100
Minced fish	45.61
First washing step ($NaHCO_3$ 0.2%)	32.38
Second washing step (Distilled water)	33.25
Third washing step (NaCl 0.15%)	27.96

Table 2. Effect of washing by various solutions on chemical composition of minced fish flesh

Constituents (%)	Unwashed minced fish	Washing solution		
		$NaHCO_3$ 0.2%	Distilled water	NaCl 0.15%
Moisture	76.05[a]	79.53[a]	81.14[a]	80.39[a]
Fat	15.59[b]	10.43[b]	8.51[b]	5.34[b]
Protein	79.2[b]	81.45[b]	83.75[b]	86.21[b]
Ash	4.68[b]	2.04[b]	0.82[b]	1.21[b]
Carbohydrate*	0.52[b]	6.08[b]	6.92[b]	7.24[b]
S.E.P.**	42.53[a]	46.36[a]	47.42[a]	48.11[a]

*By difference. **Salt extractable protein. a. Wet weight basis. b. Dry weight basis.

distilled water attained to 81.14%. This expansion might due to the water absorbed by protein molecules. The third washing step with 0.15% NaCl solution, however reduced the water content from 81.14% to 80.39%.This may be attributed to washing with saline solution. These findings are in agreement with El-Shourbagy *et al.* (2003) who stated that dewatering after washing process adjusted moisture content of washed mince to approximately that of intact fillet fish muscle.

Furthermore data in Table (1) indicated that fat content of unwashed minced fish was 15.59% decreased to 10.43%, to 8.51 and 5.34% (at dry weight basis) after the first, second and third washing steps, respectively. Separation of fat during washing steps was attributed to differences in density and polarity between fat and aqueous solution. In addition during the water washing process, lipid is normally removed from the adipose cell. Neutral lipids are typically presented at the top layer after washing and can be easily removed (Tadpitchayangkoon and Yongsawatdigul, 2009). Same trend was observed also in ash content whereas it was decreased after the first and second washing steps. However, after the third washing steps the concentration of ash and carbohydrates enhanced. This may be due to removing of fat from the mince by washing. This is consistent with findings obtained by Kim *et al.* (1996) and Mahmoud (2006).

Removal of these constituents was reflected on the protein content (Table 2) which increased from 79.2% for unwashed minced to 81.45% after the first washing with $NaHCO_3$. Similarly there was an increase after second washing to 83.75%. (on dry weight basis).The same trend was observed after third washing, where the proteins content was 86.21%. These results are confirmed with those stated by Lee *et al.* (1990), Kim *et al.* (1996) and Amira (2001) whose reported that washing and dewatering steps concentrated the protein.

Some increase in carbohydrate content was remarked after washing steps. This may attributed to remove of fat and ash from mince by washing. These results in line with that reported by Mahmoud (2006) who found that the carbohydrates in surimi catfish was 7.77%. From the same Table it could be noticed that salt extractable protein (SEP) of unwashed mince was 42.53% (from the total protein) increased to 46.36%, 47.42% and 48.11% (from the total protein) for first, second and third washing mince, respectively. These results are in agreement with Lee *et al.* (1991) who reported that the salt extractable protein content increased with additional washing steps from 76% to 96.2% after four steps of washing. Amira (2001), also declared that washing and dewatering steps concentrated the proteins, predominantly as salt extractable protein.

Influence of Three Different Washing Steps on Quality of Minced Catfish (Karmout)

Data in Table (3) indicated that there is slight change in pH of fish flesh noticed after washing steps. The greatest effect occurred by the first washing step with $NaHCO_3$, as pH was 6.44 for unwashed mince, increased to 6.64. The second washing step with distilled water caused slight rise in pH to 6.67, raised to 6.6 by the third washing El-Sharnouby and Moharram (1994) found that pH of washed bolti surimi varied from 6.8 to 7 according to washing system which was in agreement with the results reported in present work. The same table shows that WHC of unwashed mince was 74.69 increased to 77.68 and 78.74 after the first and second washing steps, and slightly decreased to 78.62% after third washing. In this concern El-Shourbagy *et al.* (2003) reached to the same results. It was observed also from the same table that there was a general decrease in TVB-N and TMA values after the employed washing steps. It was observed also from the same table that there was a general decrease in TVB-N and TMA values after the employed washing steps.

Overall, lower TVB-N values in washed minced catfish could have resulted from removal of free amino acids, sarcoplasmic protein, or N-containing compounds of non-protein nature during washing (Park and Morrissey 2000 and Suvanich 2000).

Thiobarbituric acid value (TBA) has taken as an index of fat oxidation, the tabulated data in Table (3) shows that TBA value was 0.81 mg malonaldehyde/kg for unwashed mince and decrease to 0.64, 0.41 and 0.36 after first, second and third washing steps respectively. These results indicated that efficiency of washing process for removing of fat consisting with Ahmed (2001).

Table 3. Changes of some physicochemical properties of catfish mince during washing steps

Constituents	Unwashed minced fish	Washing solution		
		$NaHCO_3$ 0.2%	Distilled water	NaCl 0.15%
pH	6.44	6.64	6.67	6.69
WHC(%weight of water loss)	74.69	77.68	78.74	78.62
TVB-N(mg TVN/100g sample)	12.75	10.52	9.75	7.35
TMA(mg TMA/100g sample)	4.62	3.25	2.26	1.43
TBA(mg malonaldehyde /kg)	0.81	0.64	0.41	0.36

Table 4. Concentration of heavy metals (Hg,Pb and Cd) in unwashed and washed catfish mince (mg/kg as wet weight basis)

Treatments	Heavy metals		
	Hg	Pb	Cd
Unwashed minced fish	0.41	0.373	0.173
First washing step ($NaHCO_3$ 0.2%)	0.38	0.357	0.168
Second washing step (distilled water)	0.371	0.352	0.162
Third washing step (NaCl 0.15%)	0.362	0.346	0.156

Table 5. Effect of washing by various solutions on microbiological counts of minced catfish (expressed as, CFU/g)

Treatment	Total bacterial count	Psychrophilic bacterial count	Coliform groups
Unwashed mince	4.1×10^5	2.4×10^5	<10
First washing step (NaHCO3 0.2%)	3.6×10^3	1.9×10^3	<10
Second washing step (distilled water)	2.6×10^3	1.2×10^3	<10
Third washing step (NaCl 0.15%)	1.4×10^3	0.6×10^3	<10

Effect of Washing Method on some Heavy Metal Content of Minced Catfish (Karmout)

From Figures presented in Table (4) it could be noticed that the concentration of Hg, Pb and Cd in unwashed minced fish were 0.41, 0.373 and 0.173 respectively.

These values decreased to lower levels attributed to get rid of fat from the minced fish by washing steps. These results are in agreement with those obtained by Kim *et al.* (1996) who stated that there was a decrease in washed minced fat content comparing with unwashed mince.

However, while the levels of Hg and pb being below the permissible limit recommended by the Egyptian Standard (1991) (0.5 Hg mg/kg and 1.0Pb mg/kg respectively), the levels of Cd values were higher than its permissible limit (0.1mgCd/kg).

Effect of Washing Steps on the Microbiological Counts of Minced Catfish (Karmout)

From the tabulated data in Table (5) it could be observed that total bacterial count was 4.1×10^5 CFU /g in unwashed catfish mince, reduced to 3.6×10^3, 2.6×10^3 and 1.4×10^3 CFU/g after first, second and third washing steps, respectively. El-Shourbagy *et al.* (2003) found that aerobic plate count bacteria (APC) of mince made from catfish was lower than his from washing minced catfish.

Furthermore, the same table revealed that psychrophilic was 2.4×10^5 for unwashed mince lowered to1.9×10^3, 1.2×10^3 and 0.6×10^3 after first, second and third washing steps respectively. This decrease might be attributed to the efficiency of washing process for removing the fat, blood, substances and low molecular weight nitrogenous compounds which help the microbial growth.

While the coliform group counts were less than 10 CFU/g before and after washing steps, it could be indicated than counts for these organisms were decrease by washing steps.

Conclusion

As a result of this study, we found that protein, WHC and SEP in mince produced from catfish (Karmout) were increased after washing steps. Also the chemical quality was in good limits. Also the microbiological counts of minced catfish were decreased after the three washing steps. Data indicated that washing minced catfish has functional properties with potential use for surimi products.

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تأثير الغسيل بثلاث خطوات على الخواص البيوكيميائيه والجوده للسوريمى المجهز من مفروم سمك القراميط *(Clarias gariepinus)*

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السوريمى عبارة عن بروتين السمك المجهز بغسيل لحم السمك المفروم منزوع الشوك.وسمك القراميط له كثير من الصفات الغير مرغوبه بما فى ذلك قصر فترة التخزين. وتحتاج عملية انتاج سوريمى القراميط إلى كميات كبيره من الماء. هناك تغيرات تحدث فى مفروم السمك أثناء إعداد السوريمى نتيجة الغسيل لابد من أن تدرس قبل محاولة خفض كمية الماء المستخدم فى التصنيع وذلك كان هو الهدف من البحث الحالى.

فى البحث تمت دراسة تأثير الغسيل على جودة لحم سمك القراميط المفروم وذلك بأتباع طريقة الغسيل ذو الثلاث خطوات للحصول على سوريمى لحم سمك القراميط المفروم. تم الغسيل باستخدام محلول بيكربونات الصوديوم ٠.٢% ثم الغسيل بالماء المقطر وأخيرا بمحلول كلوريد الصوديوم ٠.١٥%. وقد أوضحت النتائج إن اغلب الفقد فى الوزن الناتج يحدث فى المرحلة الثانية للغسيل (الماء المقطر) والمرحلة الثالثة للغسيل (بكلوريد الصوديوم) .ونتيجة للغسيل زادت نسبة الرطوبة والبروتين الكلى والبروتينات الذائبة فى المحلول الملحى بينما نقصت نسبة الدهن والرماد. كما تبين أن رقم الأس الأيدروجينى حدث به ارتفاع طفيف بالغسيل. ولقد حسن الغسيل بثلاث خطوات القدرة على الإمساك بالماء فى لحم السمك المفروم وخاصة عند المرحلة الأولى بينما نقص تدريجياً قيم النيتروجين القاعدى الكلى المتطاير وثلاثى مثيل أمين وكذلك قيم حامض الثيوباربتيورك.